Evaluation of Benefits of Screening Tests Done Immediately on Admission to Hospital

Timothy C. Durbridge,¹ Fay Edwards,¹ Robert G. Edwards,¹ and Margaret Atkinson²

Evidence was sought of improved inpatient progress and reduced hospital costs when a battery of investigations were done at the time a patient was admitted to hospital. The outcome in 500 admission-tested patients was compared with that in two other groups of 500 control patients. No significant differences were found among the three groups in a variety of indices of inpatient progress. Because of an estimated 64% increase in the cost of investigating inpatients with admission testing, the total cost of hospital care was increased by about 5%. Under the conditions of this study, admission testing added to the cost of hospitalization, without associated evidence of benefit to the patient.

Additional Keyphrases: admission screening • diagnostic aids • economics of laboratory operation

At present, Australian doctors select the timing and nature of tests done on their patients. The immediate and unsolicited investigation of inpatients at the time of admission to hospital is not routinely practiced. The aim of this study was to find out whether there were benefits in introducing this kind of admission procedure; that is, whether inpatients’ progress was improved and hospital costs were reduced. The study was instigated by the Australian National Health and Medical Research Council, which has commented that such screening procedures on admission might be introduced despite a lack of factual evidence for their value (1).

The argument in favor pointed to advantages if investigation were more rapidly completed (2), and unsolicited results aided diagnosis (3, 4). The reader will note a similarity to arguments favoring the introduction of discretionary biochemical profiling during the 1960’s. We mention this affinity, only to make clear that this study did not evaluate tests requested by doctors, whether the test requested was a single one or a profile. Our findings neither advocate nor condemn the practice of discretionary profiling; we comment that profiling is the most practical means we know for the large laboratory to manage an increasing workload of commonly requested tests.

In this experiment, the outcome seen in patients where doctors were free to request any tests, was compared to the outcome when unsolicited investigations were also performed immediately on admission, a so-called “admission screen.”

Methods

The study was done at a 1000-bed acute general teaching hospital, the Royal Adelaide Hospital. Patients were selected according to sequence of admission and allocated randomly to a Test, Control, or Dummy class. Each patient was assigned one of 90 admission categories, and sampling was continued until 500 triplets, each containing a Test, Control, and Dummy patient of the same admission category, were obtained.

Patients in the Test and Control classes were “screened” on admission. The data obtained were: narrative interpretations of electrocardiogram and chest roentgenogram; “Vitalograph” pulmonary-function trace; the biochemical “profile 1” (serum sodium, potassium, chloride, bicarbonate, urea, and glucose); “profile 2” (serum albumin, globulins, calcium, phosphate, cholesterol, uric acid, creatinine, bilirubin, alkaline phosphatase, lactate dehydrogenase, and aspartate aminotransferase); serum amylase; serum ketones; hematological profile (leukocytes, erythrocytes, hemoglobin, packed-cell volume, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration); erythrocyte sedimentation rate; prothrombin; narrative interpretation of blood film appearance; 12-h urine culture; urine dipstick chemical tests; a color vision test; blood pressure; and temperature.

All these data (excepting the urine culture result) were available to clinicians attending Test class patients about 3 h after admission.

The data were withheld in Control class patients, under the guardianship of a Peer Advisory Group, who had the authority to release Control results if it was believed that a life might be threatened by withholding the information. That authority was not exercised during this study.

Patients in the Dummy class were not screened on admission; neither clinicians nor patients were notified of their inclusion in the study.

¹Division of Clinical Chemistry, Institute of Medical and Veterinary Science, Frome Road, Adelaide, South Australia 5000.
²Department of Economics, The University of Adelaide, Adelaide.

Received Feb. 24, 1976; accepted Mar. 8, 1976.
After admission, all patients were monitored to make a variety of measurements of their progress and of costs incurred in their management. The monitors played no role in the clinical care of patients. Throughout the monitoring an effort was made not to influence attending clinicians’ management of their patients. Items pertaining to patient state, investigation, and treatment were recorded on a daily basis as nominal categories (e.g., 35 codes for drugs of differing therapeutic action) or as absolute values (e.g., temperature). Discretionary investigations were recorded on the day the report was received from the laboratory in codes indicating the type of report. All types of investigation reports were included, not just those from the clinical laboratories.

Results

Analyses of measurements made on the day of admission showed the Test, Control, and Dummy classes to be initially alike. Data collected by monitors on the first day showed no significant differences, except that more Control patients had a diastolic blood pressure exceeding 13.3 kPa (100 mmHg); more Test patients had hyperglycemia and glycosuria; and fewer Dummy patients were in an impaired state of consciousness. Demographic data collected on admission showed no significant differences. Each doctor attended a similar number of Test, Control, and Dummy patients.

Inpatient Progress

Results for 20 hematological and biochemical tests were obtained in Test and Control classes not only on admission, but also on days 3 and 8 of the patient's stay. This was done independently of any discretionary investigation, to see whether the results followed a preferable trend in the screened Test patients. Comparison between the Test and Control result distributions showed no advantage to either class on any occasion for: white blood cell count, hemoglobin, erythrocyte volume, or serum sodium, potassium, chloride, bicarbonate, albumin, globulins, calcium, phosphate, cholesterol, uric acid, creatinine, bilirubin, lactate dehydrogenase, or aspartate aminotransferase. Only three of a total of 60 comparisons of distribution showed a difference significant at P < .05; namely, a difference in Test and Control distribution of glucose results on admission only, a difference in distribution of alkaline phosphatase results on the third day only, and a difference among urea results on the eighth day only. On the eighth day there were higher urea values in the Controls than in the Tests, but there were no corresponding differences in the distributions of results for creatinine, phosphate, or uric acid. In view of possible medical significance of the difference in urea distributions, patients with urea results exceeding 10 mmol/liter were further examined. Of the 260 Control patients hospitalized for at least 8 days, 37 had an admission urea value exceeding 10 mmol/liter. The high urea in the withheld admission screen was found by prompt discretionary test in all but three of these Control cases. Slightly fewer Test patients had such a high urea in their admission screen. However, the proportion of Test patients whose high urea persisted to the 8th day (13/27) was similar to that in the Control patients (17/37). Although the urea results overall ranged between 1.0 and 47.5 mmol/liter, results of less than 2.5 or more than 10 mmol/liter were unusual, and most were within the laboratory’s reference range. The difference in urea distributions is attributable to a slight “shift to the right” of Control results within the reference range. Differences of medical importance could not be established.

Before describing other indices of inpatient progress, we will mention two incidental findings about trends in these 20 tests.

First, the within-class correlation of urea results on admission with results on day 8 was only .45, pointing to extensive redistribution of results. Such weak correlations were seen in most of the 20 tests, even between admission and day 3. Phosphate, sodium, potassium, and bicarbonate results were extensively redistributed in that time. Strongly correlated results were found only for mean erythrocyte volume and bilirubin.

Second, the trend in test results was toward an increasing number outside the laboratory's reference range as patients stayed longer in hospital, while our other measures of inpatient progress showed the expected progression toward an improved state of health.

A variety of other indices of inpatient progress showed no advantage in the admission screening procedure; this was found for screened patients overall, and for patients within subgroups based on such factors as patient's age and sex, and medical speciality. Length of hospital stay and mortality did not differ significantly between the Test, Control, and Dummy classes. Two indices of patient's disability, one after Fanshel and Bush (5) and the other a subjective assessment by a social worker, showed no significant difference among the three classes. Two indices of patients' distress, one after Rosser and Watts (6) and the other based on volunteered complaints of pain at interviews, also showed no significant difference. The duration of abnormality in all 10 monitored clinical signs was unchanged by admission screening, and medical opinion on inpatients' progress was not apparently altered either. Patient dissatisfaction was also studied, and we found only that screened patients expected fewer investigations than they had experienced.

Pattern of Inpatient Investigation

The admission screening procedure had a marked effect on the pattern of inpatient investigation, as shown in Table 1. The number of reports of all kinds of investigation has been divided up into types. The first row of Table 1 includes all reported investigations on admission. The figure of 4343 reports should be understood as follows: Each complete screen equated to 10 separate reports, if requested in the conventional discretionary way. There were less than 5000 reports because only 87% were completed on admission. (Some parts of the screen were difficult to accomplish in the emergency room; 40% of patients were unable to provide...
a urine specimen at all at the time of screening; the acutely ill had particular difficulty with pulmonary-function studies, and chest roentgenogram was precluded in 16% of patients by their condition and the length of the queue for x-ray films).

In the Control and Dummy patients, investigations in the screen could only be obtained on routine discretionary request. The second row of Table 1 shows that, on the average, clinicians requested about three of the 10 investigations after the patient had been admitted.

The third row in the table includes any second and subsequent repetition of these tests, either after screening or initial discretionary request. 32% more such requests were obtained in the Test class than in the Control class. There was also 10% more such repetition in the Control class than in the Dummy class. The last row includes reports for all tests not included in the screen; there were 15% more of these discretionary investigations in the Test class than in the Control and Dummy class. Thus, in all, admission screening was followed by some 700 extra requests. The net effect was an increase of 78% in the number of investigation reports with admission screening.

Other Aspects of Inpatient Management

With regard to the number of consultations for a second clinical opinion, it was found that 148/500 Test patients had one or more consultations; 25% higher than the number of Control or Dummy class patients.

With regard to treatment, there was a weak trend toward the use of a wider range of drugs in Test patients, but admission screening had no impact on the speed with which treatment was begun. There was no evidence of a significant difference in any other aspect of management.

Hospital Costs

Three variables were chosen to indicate the utilization by each patient of shared hospital services and facilities: namely the length of hospital stay, an index taking account of the extent of bedside nursing care received, and an index based on the areas of the hospital patients occupied during their stay. By none of these indices was there a significant difference among the three classes. Tallies of specific items of care, such as of surgical procedures, prescriptions, paramedical services, and use of bedside equipment were made, without finding an advantage for admission screening.

The greater investigation with admission screening indicates that the cost of inpatient investigation was increased. When the most commonly charged fee (7) for each type of report was used to convert from number of reports to dollars, the cost of performing investigations was found to be 64% higher with admission screening. There was no evidence that specimen collection was cheaper with admission screening. There was no decrease in the number of visits made to the patient for blood specimen collection per admission, or in the number of occasions a patient was moved about within the hospital for procedures such as roentgenography.

The net result, owing to an increased cost of investigation, was an increase of approximately 5% in the estimated cost of hospitalization.

Discussion

Both Whitehead and Wooton (8) and Leonard et al. (9) have used controlled trials to evaluate unsolicited admission testing. Neither found a significant difference in length of stay, with and without unsolicited biochemical tests. Leonard et al. compared laboratory workload and found that significantly more tests were requested by clinicians on admission testing.

In studies elsewhere, particular attention has been paid to the effect of unsolicited tests on diagnosis; it has been presumed that a change of medical opinion will benefit the patient. That kind of study has shown that unsolicited results frequently have no apparent impact on the doctor’s mind. The claim that the effect is less than it ought to be (10) may well be based on the belief that people with an unexpected abnormal result have lesions following the same natural course as patients with clinically evident disease. That belief may well not be valid (11). It may even be unwise for a clinician to rely on the serendipitous discovery of disorders through investigation (12). In short, whether the changes in clinical opinion are worthwhile is inevitably controversial.

Our study provides some unique findings on inpatients’ progress after an admission screening procedure. On comparing between the three experimental classes, our indices of the patients’ condition were found to be similar at admission, and to progress in a similar fashion throughout their stay in hospital. If progress depends on treatment, this similarity of progress should come as no surprise, because the timing and nature of drugs used, the surgical, medical, nursing, and paramedical care given were very similar in all three classes.

With regard to the 20 tests that were followed up during hospitalization, the extensive redistribution of results, found in Tests and Controls, was due in part to

---

**Table 1. Number of Investigation Reports**

<table>
<thead>
<tr>
<th>Class (500 patients)</th>
<th>Test</th>
<th>Control</th>
<th>Dummy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported screen</td>
<td>4343</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Discretionary requests**

<table>
<thead>
<tr>
<th></th>
<th>Test</th>
<th>Control</th>
<th>Dummy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial, for test in screen</td>
<td>89</td>
<td>1490</td>
<td>1401</td>
</tr>
<tr>
<td>Subsequent repeats</td>
<td>1886</td>
<td>1428</td>
<td>1294</td>
</tr>
<tr>
<td>All other tests</td>
<td>2045</td>
<td>1770</td>
<td>1757</td>
</tr>
<tr>
<td>Total</td>
<td>8363</td>
<td>4688</td>
<td>4452</td>
</tr>
</tbody>
</table>

a The number of investigations reported to attending clinicians for all patients within a class is shown. Each such investigation may consist of a profile of tests, but corresponds to a single report sent from the laboratory, radiology, cardiology, or other services.

b Significant difference between classes, P <.05.
analytical error. Nevertheless, it could be that allowing the attending clinician to select the time of specimen collection yields the results that are of most help to him. The progression in number of results outside the reference range may not be completely explained by known factors such as a decrease in albumin with time. We speculate that other common factors contribute to the changes—for example, treatment, because the use of various drugs is associated with abnormalities in test results. Whatever the nature of these perturbations, the Test and Control classes were equally affected.

Informing the clinician of admission test results at the outset did not make much difference in the biochemical results obtained after admission. A plausible explanation is that clinicians attending control patients usually requested those tests for which the result might affect their mode of treatment; the results that could have made a difference would thus have been obtained in any case. In other words, we have found no evidence that patients need more or speedier investigation than their attending doctor requests.

Such a conclusion is strengthened by the remarkable finding that length of stay was unchanged by rapid delivery of those test results that would in the normal course of events have arrived a day or so later. This implies that the delivery time of these test results is not as a rule critical in the steps leading to discharge.

Nonetheless, there was a changed pattern of inpatient investigation after admission screening; more tests were done after the first round of investigation, more with screening than without it. Of course, clinicians had more results to interpret after screening. Presumably tests are requested when doctors find their clinical opinion disturbed, for as well as more tests, doctors also obtained a second clinical opinion in more patients after screening. We attribute our positive findings to the unsolicited tests in the admission procedure.

In view of our findings of increased hospital cost without associated evidence of benefit to the patient, it would be unreasonable to advocate the introduction of this kind of hospital admission procedure into the current teaching hospital framework. Also it is hoped that these findings will encourage a vigorous approach in future evaluations of the benefits of discretionary investigatory services.

This study was conducted for and funded by the National Health and Medical Research Council. The Royal Adelaide Hospital staff gave much-appreciated assistance throughout the study.

References